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L. O. HOWARD, Chief.

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PEAR BORER.[1]

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INTRODUCTION.

The common name "pear borer," long ago bestowed upon the insect which forms the subject of this bulletin, is something of a misnomer, since the species attacks apple more extensively than pear. The name "apple crotch-borer" would be much more suggestive of the general habits of the insect. The species occurs over the eastern portion of the United States and in this region a few of the larvæ usually may be found boring in the bark of almost any old apple tree that may be examined. So long as the attack is limited to only a few borers the effect on the general health of the tree is scarcely perceptible, but occasionally the insects concentrate in certain trees and there breed in numbers year after year. The injury which follows is cumulative, resulting in depleted vigor, and often in the death of a part or all of the tree. On the whole, this borer is more injurious than is commonly supposed.

The following pages contain an account of this insect which is based very largely upon data collected by the Bureau of Entomology during the past five years. In gathering the data several badly infested apple orchards in Pennsylvania, West Virginia, and Mississippi were visited for the purpose of noting the extent of injury, conducting biological studies, and testing methods of control.

[1] *Ægeria pyri* Harris; order Lepidoptera, family Aegeriidae.

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HISTORY AND DISTRIBUTION.

The pear borer is a native American insect that was first described by Dr. Thaddeus W. Harris[2] in 1830. It is rather widely distributed in the eastern part of this country, having been recorded from the following States: Maine, New York, New Jersey, Pennsylvania, Michigan, Maryland, West Virginia, Virginia, North Carolina, South Carolina, Georgia, Mississippi, Alabama, Missouri, and Texas. The species no doubt occurs in several States not included in the foregoing list.

SYNONYMY.[3]

Aegeria pyri Harris, New England Farmer, v. 9, 1830, p. 2; Amer. Journ. Arts & Sciences, v. 36, 1839, p. 313; Ins. Inj. Veget., 1841, p. 235; ibid, 2d ed., 1852, p. 256; ibid., 3d ed., 1862, p. 335; Harris's Corresp. (Scudder), 1869, p. 361; Walker, Cat. Lepid. Brit. Mus., Pt. VIII, 1856, p. 45; Packard, Guide Study Insects, 1869, p. 278 (and other editions); Thomas, 1st Rept. Nox. Ins. Illinois, 1876 (1878), p. 40; ibid, 2d Rept. 1877 (1878), p. 170; Stout, Rept. Kansas Hort. Soc. 1879 (1880), p. 88; Martin, Thomas's 5th Rept. Nox. Ins. Ill. 1880 (1881), p. 107; Kellicott, Can. Ent., v. 13, 1881, p. 8; Grote, Check List N. Am. Moths, 1882, p. 12; Weed, Am. Nat., v. 23, 1889, p. 1108, fig.; U. S. Dept. Agr., Div. Ent., Ins. Life, v. 4, 1891, p. 34; Saunders's Ins. Inj. to Fruit, 1883, p. 140, fig. 146; ibid., 2d ed., 1889, p. 140; Riley, Proc. Ent. Soc. Wash., v. 1, 1888, p. 85; Beutenmüller, Ann. N. Y. Acad. Sci., v. 5, 1890, p. 204.

Trochilium pyri Fitch, 3d Rept. Nox Ins. N. Y., 1856, p. 349; Morris, Synop. Lepid. N. Am., 1862, p. 141.

Sesia pyri Boisduval, Suites à Buffon, Nat. Hist. Lepid. Het., v. 1, 1874, p. 440; Smith, Cat. Ins. N. J., 1890, p. 289; Beutenmüller, Bul. Am. Mus. Nat. Hist., v. 8, 1896, p. 139; ibid., v. 9, 1897, p. 220; Beutenmüller, Memoirs Am. Mus. Nat. Hist., v. 1, Pt. VI, 1901, p. 297.

Aegeria koebelei, Henry Edwards, Papilio, v. 1, 1881, p. 196; Grote, New Check List N. Am. Moths, 1882, p. 12; Beutenmüller, Bul. Am. Mus. Nat. Hist., v. 4, 1892, p. 173.

FOOD PLANTS.

Larvæ of the pear borer have been found commonly attacking pear and apple. Dr. J. B. Smith[4] records mountain ash (*Sorbus americana*) as a host plant. The writer has found the larvæ attacking juneberry (*Amelanchier canadensis*) and thorn (*Crataegus* sp.), and in black knots caused by *Plowrightia morbosa* on wild and cultivated cherry (*Prunus* spp.).

NATURE OF INJURY.

Injury is done by the larvæ feeding in the bark (Pl. II, B), the burrows occasionally extending slightly into the sapwood. In infested orchards particular trees on which the moths deposit most of their eggs year after year usually occur. This preference for certain trees

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[2] HARRIS, T. W., INSECTS. *In* New England Farmer, v. 9. (1830–31), no. 1, p. 1–2, July, 1830.

[3] The writer desires to express his thanks to Messrs. P. W. Mason and August Busck, of the Bureau of Entomology, for compiling and approving the synonymy as presented, and to Mr. Mason for supplying notes on the history, distribution, and food plants of the species under consideration.

[4] SMITH, J. B. REPORT OF THE INSECTS OF NEW JERSEY. *In* Ann. Rept. N. J. Sta. Museum for 1909, p. 519. 1910.

is probably due chiefly to the fact that the continuous working of generations of larvæ in the bark causes a roughened surface (Pl. II, A, C) which is attractive to the ovipositing adults. Injury may occur at almost any point above the ground, except on the smaller twigs.

Larvæ are commonly found feeding in the crotches and in places where there is a rough or broken surface caused by the previous feeding of their own kind or by other agencies. (Pl. II, A, C; Pl. III.) Favorite places of attack are around the borders of mechanical wounds in the bark, areas affected by sun scald and winter injury, and around the burrows of other species of borers. The larvæ often develop within the excrescences of stem tumor (*Bacterium tumefaciens*) and black knot (*Plowrightia morbosa*), and about the borders of dead areas caused by pear blight (*Bacillus amylovorus*). The writer has found pear borers attacking trees under the following conditions: In stem tumor of apple at Quincy, Pa., Adrian, W. Va., Demorest, Ga., Gadsden, Ala., and Love Station, Miss.; in black knots on cultivated cherry and wild cherry (*Prunus virginiana*) at French Creek, W. Va., and Winthrop, Me.; in wounds made by roundheaded apple-tree borers (*Saperda candida* Fab.) in cultivated apple and juneberry trees (*Amelanchier canadensis*) at French Creek, W. Va., and Biltmore, N. C.; in wounds made in cultivated apple and wild thorn trees (*Crataegus* sp.) by the spotted apple-tree borer (*Saperda cretata* Newm.) at French Creek, W. Va., and East Lansing, Mich.; in wounds made in apple trees by the flatheaded apple-tree borer (*Chrysobothris femorata* Fab.) at French Creek, W. Va.; in wounds made in apple bark by the yellow-bellied sapsucker (*Sphyrapicus varius varius*) at Moorefield, W. Va., and Demorest, Ga.; and in the edges of wounds made in the operation of grafting apple trees at Lancaster and Quincy, Pa., and French Creek, W. Va. Where the larvæ were feeding in the position last named they were interfering seriously with the union of stock and scion. Mr. E. B. Blakeslee, of the Bureau of Entomology, in notes furnished to the writer, states that at Winchester, Va., pear borers have been observed to complete the girdling of apple trunks partially encircled by collar blight.

The damage done by a single borer is usually negligible, but the combined injury of a dozen or more borers may endanger the health or life of the tree. Often infested areas will occur at the upper part of the trunk where a number of branches originate (Pl. II, A, C) and the branches will die one by one until the tree is ruined. Badly infested trees usually take on a scraggly, neglected appearance, the bark being rough and the growth slow. (Pl. III.) Several orchards were visited during the present investigation in which it was not unusual to find from a dozen to a hundred borers working in a single tree. Under such conditions treatment of some kind for saving the trees is necessary.

THE EGG.

The egg (Pl. I, A) is light glossy brown, oval, and flattened. One end is slightly truncate and one side distinctly concave, the depressed area being elongate and covering half the central surface of the side. Length 0.6 mm., width 0.3 mm.

THE LARVA.

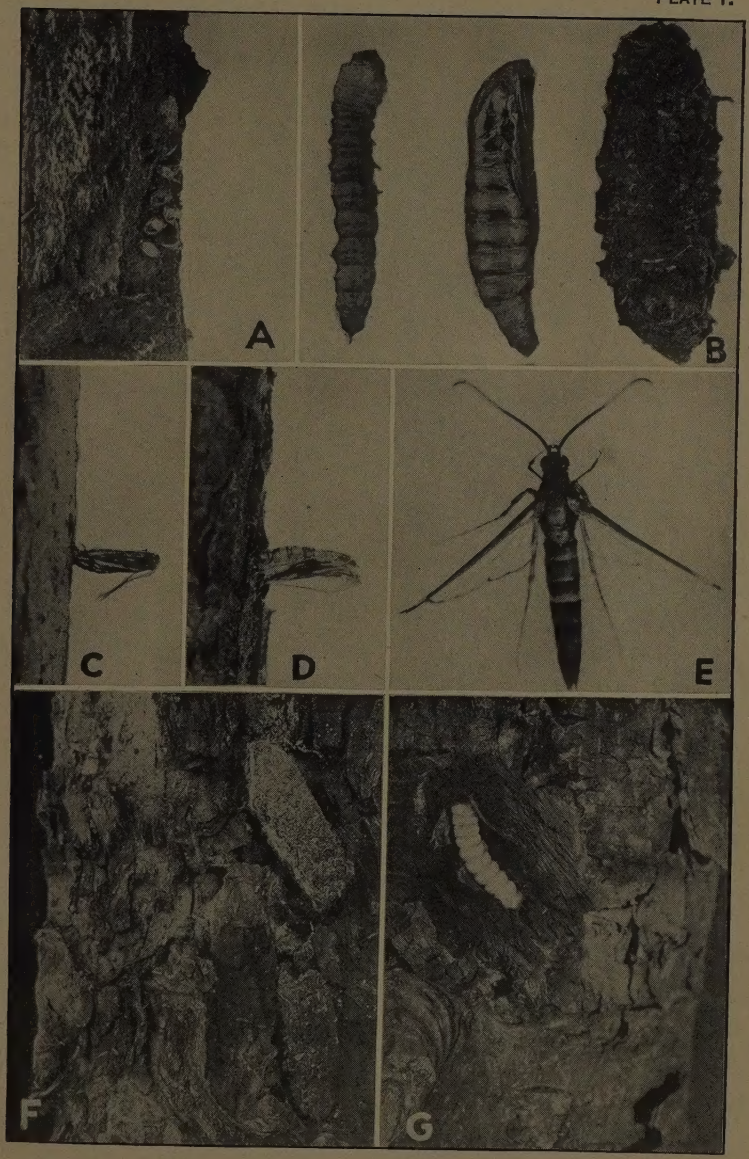
The larva (Pl. I, B, G; Pl. II, B, D) is creamy white with a brown head, the average length of full-grown specimens being about 15 mm. and the width slightly more than 2 mm. The thoracic and abdominal segments from the first to the tenth are uniform in width. Segments 11, 12, and 13 taper abruptly to a blunt point. Throughout, the body is very sparsely clothed with short, stiff hairs.

The larvæ feed almost exclusively on the inner bark, although occasionally, where the bark is thin, they will gnaw slightly into the sapwood. When feeding in the excrescences of black knot or stem tumor they penetrate into all parts of the porous tissue; also, after feeding at the edge of dead areas on the tree, full-grown borers sometimes penetrate into near-by decaying wood to construct their cocoons. Usually, however, feeding is confined to the bark of the trunk and larger branches.

The completed burrows vary greatly in shape, but are usually in the form of broad, elongate, central spaces with short galleries leading off in different directions.

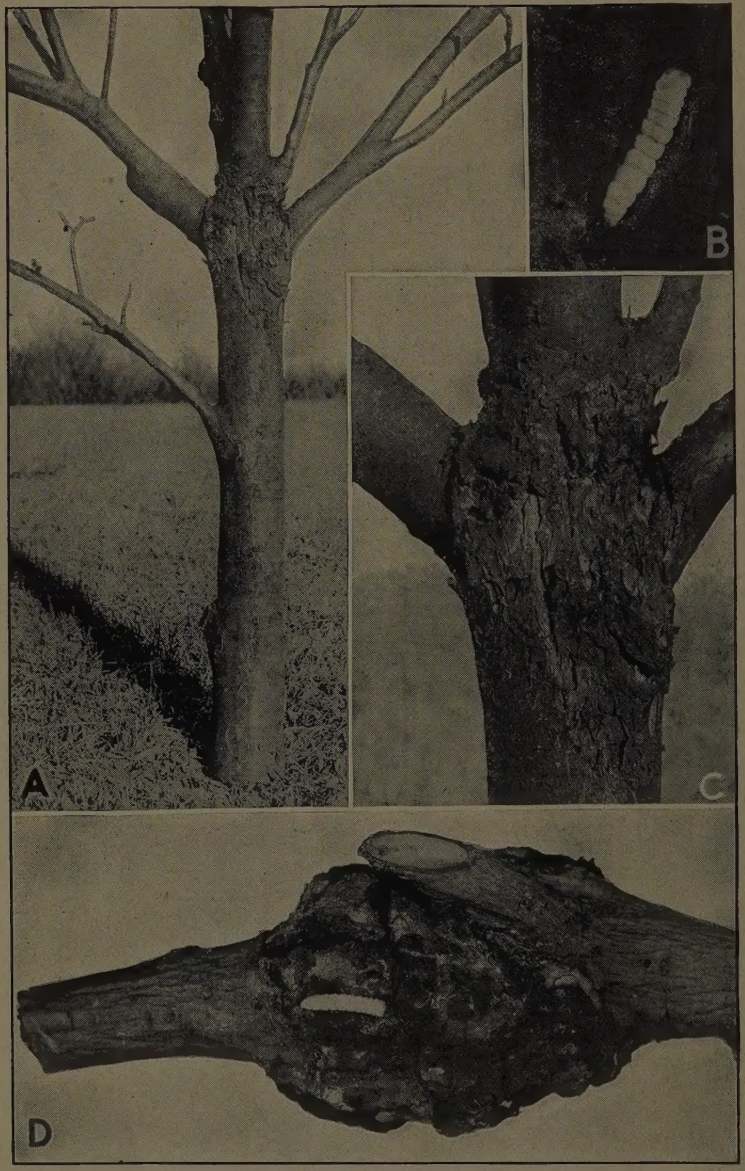
Larval activity begins early in the spring and is marked by the ejection of fresh, reddish castings through the bark and, often, by a few drops of brownish water oozing from the wounds. Active feeding has been observed in West Virginia as early as the last of March. The larva winters in a silk-lined hibernaculum constructed in that part of the burrow where the larva chances to be when overtaken by the cool weather of autumn. (Pl. I, G.) Some of the larvæ attain full growth in the fall, and, after wintering in their hibernacula, construct cocoons in the spring without further feeding. These cocoons are formed by reshaping and adding to the hibernacula.

In West Virginia there are both one-year and two-year larval periods, the duration of this stage of the insect's existence evidently depending somewhat upon food conditions but more upon the time in the season when the larva hatched. Apparently, larvæ from early-laid eggs usually transform to adults the following season, having thus a one-year life cycle, while those from late-laid eggs live in the tree as larvæ over two winters, having a two-year life cycle. On account of the difficulty of obtaining eggs, no individuals were reared under constant observation from eggs to adults. Over a hundred newly hatched larvæ, however, were collected at various times in the summer and planted in apple trees where their develop-



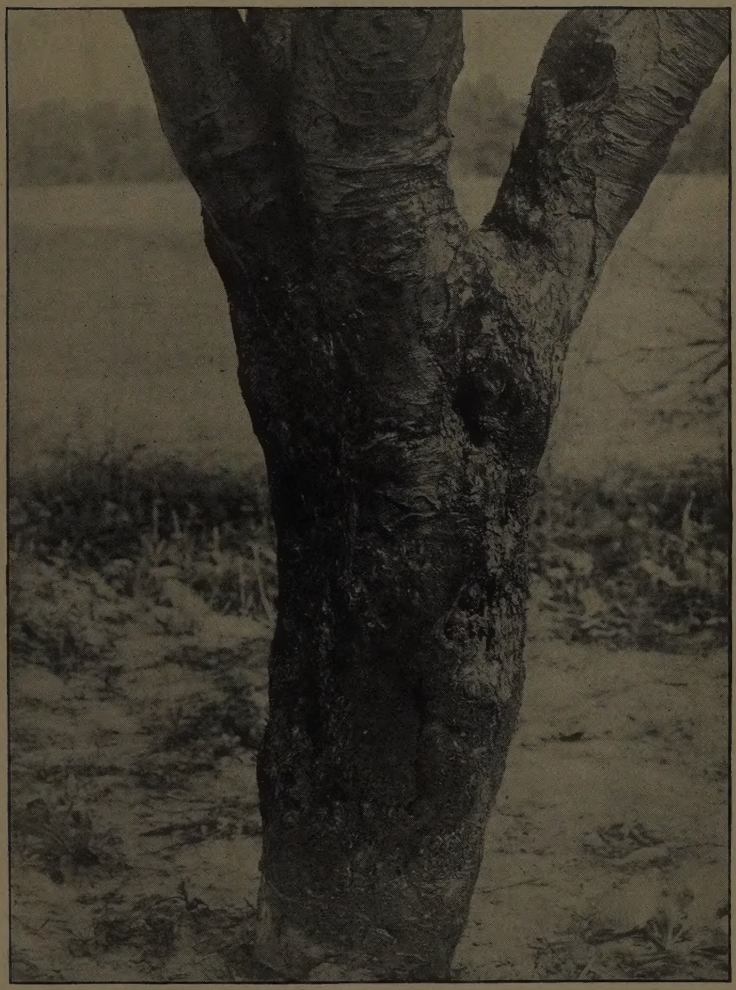
STAGES OF THE PEAR BORER.

A, Eggs in natural position; much enlarged. *B*, Larva, pupa, and cocoon; enlarged. *C*, *D*, Empty pupa cases projecting from the bark. *E*, Adult. *F*, Cocoons exposed by removing scales of apple bark; enlarged. *G*, Larva in hibernaculum; slightly enlarged.



PEAR BORER AND NATURE OF INJURY TO TREES.

A, Young apple tree showing characteristic injury at base of larger branches. *B*, Larva in burrow in apple bark; enlarged. *C*, Same as *A*, showing injury more in detail. *D*, Borer working in excrescence on apple branch; natural size.



TRUNK OF APPLE TREE, SHOWING SERIOUS INJURY BY PEAR BORER.

ment could be watched. Of these approximately 25 per cent had a one-year larval period and 75 per cent had a two-year larval period. It is possible that in the South, where the annual feeding season is longer, a one-year larval period may be the rule, while in the North, where the summers are shorter, there may be a constant two-year period for this stage.

THE PUPA.

Pupation takes place within an oblong-ovate cocoon formed of small particles of wood held together by a tough fiber of silk. The cocoon is always hidden beneath a scale of bark or wood fragments. (Pl. I, B, *f*.) The pupa (Pl. I, B), which is from 8 to 10 mm. in length, is at first yellowish white in color but soon changes to brown, the shade of color deepening as the imaginal stage is approached. The posterior margins of the abdominal segments are marked with rings of slightly darker brown. The segments beyond the sixth are armed each with two rings of saw-tooth-like points which slant backward, the points on the front ring of each segment being strongest and extending at the ends slightly beyond the spiracles. The points on segments beyond the eighth are stronger than those in front.

When the adult is ready to issue the pupa works forward until only the tip of the abdomen remains in the cocoon and the posterior end projects out through the bark. The pupa case then splits across the head just back of the antennæ, the rupture sometimes extending down the back of the thorax, and the moth issues suddenly and crawls away a short distance to harden. The empty pupa case is left projecting from the bark. (Pl. I, C, D.) In one case observed the pupal stage covered a period of 23 days. Table I indicates the time when cocoons are constructed in various localities and shows other vernal activities of the insect.

TABLE I.—*Spring activities of the pear borer.*

Year.	Month and day.	Locality.	Remarks.
1912	June 5	French Creek, W. Va..	Cocoons plentiful. Moths issuing.
1913	Apr. 18	Moorefield, W. Va.....	Cocoons found on old apple tree.
1915	June 21	French Creek, W. Va..	About half of individuals in cocoon.
1915	June 29	.....do.....	Of 60 individuals 4 had pupated.
1915	Apr. 25	Holly Springs, Miss...	A few larvæ have entered cocoons.
1915	Apr. 29	Gadsden, Ala.....	Several cocoons found on apple tree.
1915	May 4	Biltmore, N. C.....	No cocoons. Larvæ plentiful.
1916	May 12	French Creek, W. Va..	Less than half are in cocoons.
1916	June 16	Winthrop, Me.....	No cocoons. Larvæ plentiful.
1917	May 16	French Creek, W. Va..	Cocoons with larvæ in them.
1917	May 18	.....do.....	1 pupated May 18, adult June 11.
1918	May 6	.....do.....	Cocoons present on apple trees.
1918	May 8	.....do.....	About half the larvæ are in cocoons.

It may be seen from the foregoing table that at French Creek, W. Va., where most of the observations were made, the first cocoons were found on May 6 and the last on June 29.

THE ADULT.

The adult of the pear borer (Pl. I, E) is a dainty little moth having an expanse of from 12 to 17 mm. and a length of from 7 to 10 mm. The wings are transparent, veined, bordered, fringed, and tipped with metallic purplish black or brownish black, the dark areas being partially covered beneath with yellow scales. The upper parts of the body are purplish black with white and yellow markings on the head, yellow markings on the thorax, and three more or less distinct yellow bands around the abdomen. The legs and underparts are heavily marked with golden yellow, the antennæ and anal brush usually being marked with the same color. The colors throughout have a metallic luster, especially in fresh specimens. The scales rub off easily and there is considerable variation in color marks on this account, especially with specimens taken in the field.

Table II, based on field and laboratory notes, indicates the time of year when moths are found issuing in different localities.

TABLE II.—*Time of issuing of pear borer moths in different localities.*

Year.	Month and day.	Locality.	Remarks.
1911	Aug. 15	French Creek, W. Va.	One moth issued.
1911	Aug. 27	....do	Do.
1912	June 4	....do	First moth of season issued.
1913	May 13	Moorefield, W. Va.	Moth issued from cocoon found April 18.
1915	June 21	French Creek, W. Va.	First moth of season issued.
1915	Apr. 29	Gadsden, Ala.	Moths were issuing from cocoons on apple.
1915	Apr. 26	Love Station, Miss.	2 moths had issued from cocoons.
1916	May 19	French Creek, W. Va.	8 moths issued from May 19 to June 2.
1916	July 20	....do	2 moths from material brought from Maine.
1916	July 22	....do	Moth issued from cocoon from Michigan.
1917	June 11	....do	Moth issued that had pupated 23 days before.
1918	May 11	....do	First moth of season issued.
1918	June 1	....do	Moths issuing in abundance.
1919	June 18	Quincy, Pa.	Many moths flying in apple orchard.

The foregoing table shows that the earliest record for moths is April 26, at Love Station, Miss. At French Creek, W. Va., where the rearing work was done, moths issued from May 11 to August 27, emergence covering a period of 108 days.

OVIPOSITION.

Many attempts were made to observe oviposition before the act was finally witnessed. Ovipositing females were first observed on June 18–19, 1919, in a large apple orchard at Quincy, Pa. The weather at the time was clear and warm and oviposition took place during the brighter part of the day, being most active from 10 a. m. to 4 p. m.

A series of badly infested trees were located and by visiting one tree after another a number of female moths were found hovering about the trunks and the bases of the larger branches. Their flight was rapid and wasplike but the light-colored markings of the ab-

domen and antennæ made the insects fairly conspicuous against the dark background of bark. The moths had to be approached warily, for they were quick to take alarm at any careless motions made in their near presence. When frightened they disappeared almost instantly and it was useless to try to follow them to another tree. In ovipositing the moths flew with a wavering, gliding movement near to the tree with the antennæ brushing the bark. They alighted at frequent intervals and moved the tip of the abdomen back and forth as they crawled over the bark seeking for a rough surface or a crack in which to place an egg. Sometimes the entire abdomen would be inserted under a scale of bark, or into an opening, where it would be held motionless for a second while the egg was being laid. Evidently a female lays only one egg in a place at a time, but repeated visits of females to a suitable location result in the eggs being grouped together by the end of the oviposition season. In one instance seven eggs were found in a heap at the bottom of a crack in the bark. The eggs are so small and inconspicuous that it is next to impossible to find them on the bark, even with an ordinary hand lens. Specimens of bark on which female moths had been seen to alight, but on which no eggs could be found in the field, were taken to the laboratory and placed under a microscope, where numerous eggs were easily discovered.

CANNIBALISTIC TENDENCIES.

In several instances a number of larvæ of different sizes were collected in the field and placed with pieces of live apple bark in large vials to be taken to the insectary. Sometimes the larvæ would be retained in the vials for several days. In all such cases it was found that the larger larvæ would kill and devour the smaller. That cannibalism is sometimes practiced under normal conditions is indicated by the fact that the larvæ are always found occupying burrows independent of one another, although eggs are frequently laid in groups. In a few cases small larvæ were found devouring their own kind on the trees.

NATURAL ENEMIES.

It is a common thing to find burrows of the pear borer that have been opened and the occupants removed by woodpeckers, although the species of bird responsible has not been observed. The larvæ and pupæ are rather extensively attacked by parasites, perhaps 50 per cent of them being destroyed in this way. Table III gives a list of the hymenopterous parasites reared by the writer from the pear borer. In addition to the species named in the table, there is a record of another parasite, *Stilbopoides sesiavora* Roh.,[5] reared from this host.

[5] Rohwer, S. A. Descriptions of new parasitic Hymenoptera. *In* Proc. Ent. Soc., v. 15, p. 180–188, 1913.

TABLE III.—*Hymenopterous parasites reared from the pear borer, Aegeria pyri Harris.*

Quaintance Series No.	Name.	Locality.	Year.	Determined by—
9402	*Microbracon* sp.	Gadsden, Ala.	1915	R. A. Cushman.
9407	*Phaeogenes ater* Cress.	Love Station, Miss.	1915	S. A. Rohwer.
9429	*Lissonota* n. sp.	French Creek, W. Va.	1915	R. A. Cushman.
9431	*Ilopleetis annulipes* (Brullé).	do.	1915	Do.
9468	*Macrocentrus* n. sp.	do.	1917	S. A. Rohwer.
9499	*Ephialtes aequalis* (Prov.).	do.	1918	Do.
9531	*Tetrastichus* sp.	do.	1919	A. B. Gahan.
9539	*Ephialtes aequalis* (Prov.).	Quincy, Pa.	1919	R. A. Cushman.

METHODS OF CONTROL.

The borers of this species work so near the surface that they can usually be removed with a sharp knife without difficulty and without much injury to the tree. It is not always easy to locate their burrows, but as a rule exuding frass and often a spot of moisture on the bark show where the insects are working. The rough places on the bark where groups of borers feed continuously can be pared away with a knife, the borers removed, and then the surface covered with coal-tar creosote tree paint or white-lead paint. Such a coat of paint is not only beneficial in protecting the wounds from air and moisture, but to some degree it prevents reinfestation by the insects. In one case in a badly infested apple orchard, in the State of Mississippi, several applications of a heavy paint to the rough areas where the borers were congregated served almost entirely to rid the trees, for a few years at least, of these insects. It was found also that applications of viscous material, such as is used on sticky fly paper, made in the summer to these rough places, entangled many of the moths when they visited the places to lay their eggs.

The shallow burrows of this species make it possible to kill many of the borers by applications to the bark of penetrating oily or poisonous liquids. Kerosene emulsion and the standard emulsified oil sprays, with small quantities of sodium arsenate added, when applied to the bark over the burrows killed as high as 85 per cent of the borers. Nicotine sulphate washes were less effective, but some of the coal-tar products killed over 90 per cent of the borers without perceptible injury to the bark. The heavy oil materials, however, should always be used with caution until assurance is obtained of their noninjurious effects upon the trees.

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